PATENT SPECIFICATION

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DRAWINGS ATTACHED

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(54) IMPROVEMENTS IN OR RELATING TO PERMANENT MAGNET D.C. MOTORS

(71) We, NIPPON ELECTRIC COMPANY LIMITED, a Japanese Company, of 7—15, Shiba Gochome, Minato-ku, Tokyo-to, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to permanent magnet D.C. motors, particularly but not exclusively for use as a driving motor for a recording pen at the receiving end of a remote automatic graphic information transmission system wherein information such as letters, numerals and figures—each of which is being hand-written at the transmitting end; with a ball point pen, for instance; is transformed into electric signals by a transmitter and is sent through a communication line to a remote receiver, where a recording pen is moved, simultaneously with and simulating the movement of the pen at the transmitting end and thus makes a facsimile record of the information written at the transmitting end.

In this kind of communication apparatus, a small D.C. motor is usually used for driving the recording pen. This motor is used for controlling the movement of the recording pen, and the exact movement of said pen is dependent upon the exact movement of the motor. Any error in the movement of the motor due to extraneous forces interfering with the exact movement results in a corresponding error in the movement applied by the motor to move the pen.

The object of the present invention is to obviate such errors.

The invention will be clearly understood from the following description with reference to the accompanying drawings in which:—

Fig. 1 shows a cross-sectional view of the structure of a permanent magnet D.C. motor of known type;

Fig. 2 shows a similar cross-sectional view of a motor structure in accordance with the present invention; and

Fig. 3 shows comparative characteristics curves.

Fig. 1 shows a sectional view of a permanent magnet D.C. motor. The motor stator is in two halves 3, 4 the opposing surfaces 22, 23 of which are cut away in steps 18, 19 and 20, 21 at each of two opposite edges, and are formed with semi-cylindrical recesses 5, 6 on a central axis parallel to said opposite edges. Permanent bar magnets 1, 2 fit between the steps 18, 20 so as to space the surfaces 22, 23, and so that the recessed poles 5, 6 of the stator halves 3, 4 are set facing each other and form a split cylinder. A cylindrical rotor 7 cut away at 14, 15 to form a spool is wound with coils 8 and 9 and is coaxially mounted within the split cylinder bounded by the stator poles 5, 6. The air gaps between the cylindrical faces 5, 6 of each half of the stator 3, 4 and the surfaces 10, 11 of the rotor are uniformly spaced. The magnetic flux paths of the permanent magnets 1, 2 follow magnetic circuits such as 12 and 13. The movement of the rotor 7 of said permanent magnet D.C. motor is angularly limited.

To obtain correct operation of a motor, it is required to generate a strong torque with a very small current, and the driving torque needs to remain absolutely constant. In order to make the small motor generate a torque with a very small current, it is necessary to increase both the number of windings of the coils 8, 9 and the flux density within the motor due to the permanent magnets. However, owing to the shape of each half of the stator 3, 4 and to manufacturing variations in the air gaps between the cylindrical faces 5, 6 of the stator halves 3, 4 and the surfaces 10, 11 of the rotor 7 the magnetic flux density in said air gaps will not be uniform; hence in the case of a permanent magnet D.C. motor heretofore in use; if it is tried to rotate the rotor in an arbitrary direction even when no current is applied to the driving coils 8 and 9, a torque is generated to turn the rotor back to a

former arbitrary stable position. Because of this restoring torque, the momentary location of the writing pen at the sending end does not appear at the same position at the receiving end, thus causing a distortional error.

The structure of the motor shown in Fig. 2 which embodies the invention is the same as that of Fig. 1, except that the stator pole faces 16, 17 of each half 3, 4 of the stator are of elliptical shape instead of the broken line cylindrical form 5, 6.

The object of making the shape of the stator pole faces 16, 17 of each half, 3, 4 of the stator in Fig. 2 elliptical is to make the restoring torque small in order to make the magnetic flux density in the air gaps between the faces 16, 17 of the stator and the surfaces 10, 11 of the rotor 7 substantially uniform. This, as explained below, is because the air gap is now large at locations where the magnetic flux has high density, and the air gap is small at locations wherein the magnetic flux has low density.

Thus, in Fig. 1, the magnetic flux paths due to the magnets 1, 2 are generally as indicated by numerals 12, 13: they repel each other on the line X—X[1] and a neutral line is formed. The magnetic flux from the permanent magnets 1, 2 are considered to form, near the line X—X[1] an area within which it is difficult for them to pass each other taking into consideration the distribution of the magnetic flux within the effective rotation region of the rotor.

If a near-complete cylinder without coil-insertion-slots 14 and 15 is coaxially inserted, instead of the rotor 7, into the cylindrical stator housing it is considered that even if the air gaps between stator and rotor are uniform; the magnetic flux density in various parts of the air gaps are not necessarily uniform, and that the flux density is minimum on the line X—X[1] and becomes gradually larger the more distant from the line X—X[1]. When the actual rotor 7 with its coil-insertion-slots 14, 15, is inserted into the elliptical stator housing and consequently into the magnetic circuits, the coil-insertion-slots 14, 15 can be assumed to be air gaps through which passage of the magnetic flux is difficult. In Fig. 1, therefore, when the axis of the coil-insertion-slots of the rotor 7 is positioned on the center line X—X[1], as shown, the magnetic fluxes can easily pass through the spool heads of the rotor 7. When the rotor 7 rotates from this position sufficiently to introduce the air gaps into the flux paths, the total flux decreases; because of this, restoring torque is generated which increases the total flux.

Fig. 3 shows experimental characteristic curves in which the restoring torque is plotted on the ordinate and the rotary angle of the rotor is on the abscissa. It is taken as "0" point when the center of the coil-insertion-slots 14 and 15 of the rotor shown in Fig. 1 is located on the center line X—X[1]; the counterclockwise rotation is plotted on its left side, and clockwise rotation is on its right side. Curve A indicates a case in which an arbitrary uniform air gap is properly provided, and curve B indicates a case in which the minimum air gap is the same as that of the curve A and the air gap is modified as in the present invention by making the cylindrical shape formed by each half of the stator 3 and 4 to be elliptical. As can be seen in Fig. 3, the present invention is, by making the distribution condition of the magnetic flux density substantially uniform, capable of making the restoring torque small within the range of rotation when the excitation of coil is removed. In other words, it can be seen from Fig. 3, that by maintaining the magnetic flux density in the rotor substantially uniform over an angular range of movement of the rotor, the restoring torque is small whatever the rotor position, and therefore the recording pen will remain stationary when excitation of the coil is removed.

WHAT WE CLAIM IS:—

1. A D.C. motor for use in raising the fidelity of the received graphic information in a remote automatic graphic information receiver which comprises a rotor whose outline is substantially circular mounted in a stator bore which is substantially elliptical in cross section and wherein the stator is formed at diametrically-opposed points on the major axis of the cross section with gaps spanned by permanent magnets disposed in the same magnetic sense, whereby the distribution of the lines of magnetic force remains substantially uniform throughout rotation in the space between the outer surface of the rotor and the opposing inner surfaces of the stator.

2. A permanent magnet D.C. electric motor wherein the stator bore is substantially elliptical in cross-section and wherein the stator is formed at diametrically-opposed points on the major axis of the cross-section with gaps spanned by permanent magnets disposed in the same magnetic sense.

3. A receiver for an electrical facsimile communication system comprising a recording pen driving motor as claimed in claim 2.

4. A permanent-magnet D.C. motor as claimed in claim 1 substantially as described and substantially as shown in Fig. 2 of the accompanying drawings.

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1213463 COMPLETE SPECIFICATION

1 SHEET This drawing is a reproduction of the Original on a reduced scale

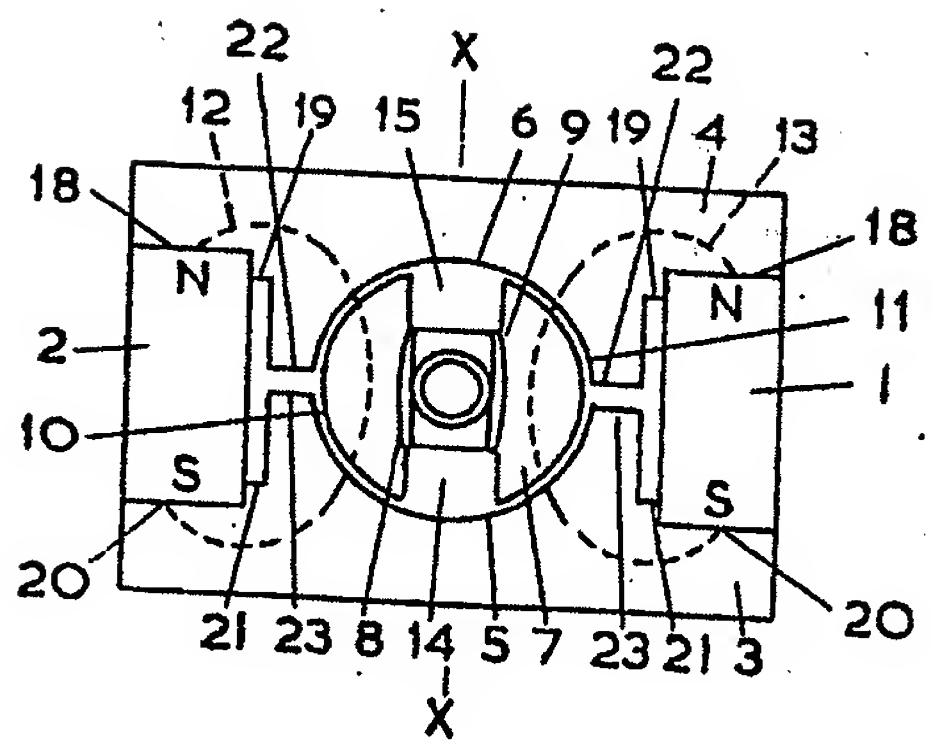

FIG. 1

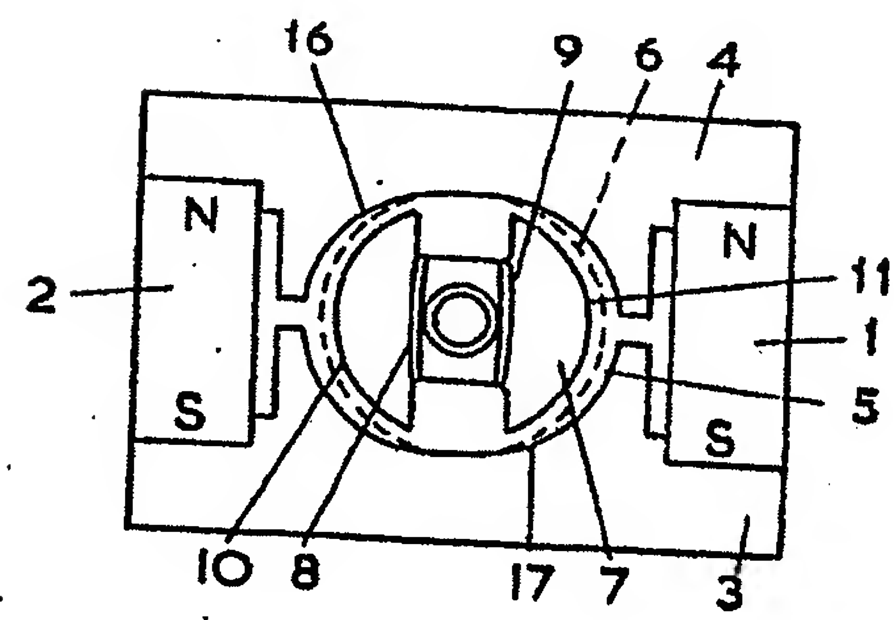

FIG. 2

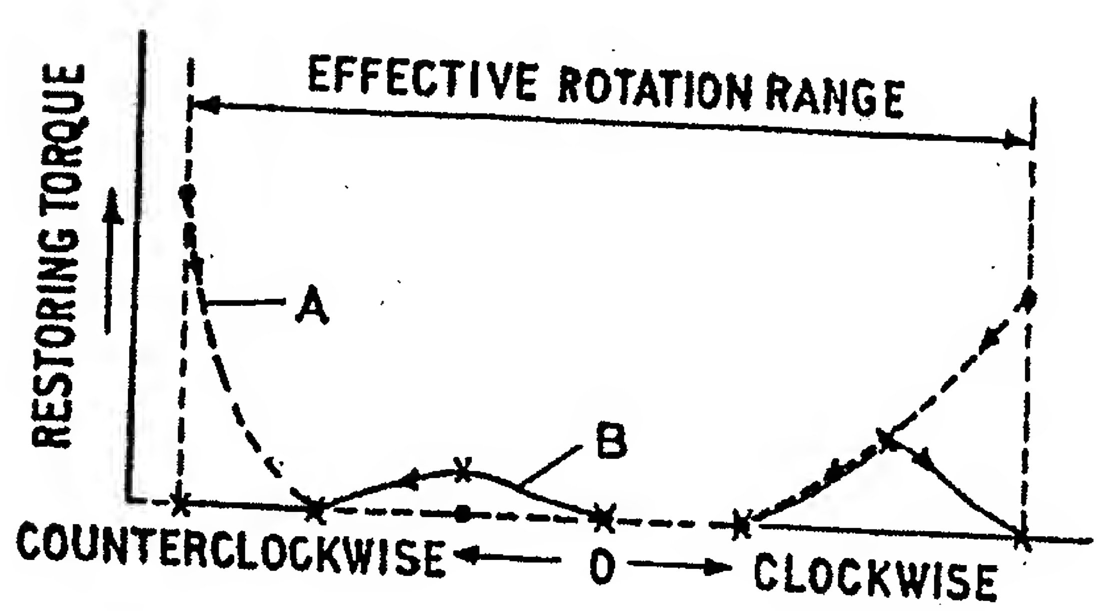

FIG. 3